MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2016/2017

PGC0225 – GENERAL CHEMISTRY

(Foundation in Life Sciences students only)

13 OCTOBER 2016
9.00 a.m – 11.00 a.m

(2 Hours)

INSTRUCTIONS TO STUDENT

1. This question paper consists of **5** pages only excluding the cover page.
2. Answer **ALL** questions.
3. Please write all your answers in the answer booklet provided.
4. Distribution of marks for each question is given.
5. Calculator is permitted.

Instructions: Answer **ALL** questions.

Question 1 [20 marks]

a. Hot aluminium reacts with chlorine gas to form aluminium chloride.

$$2Al(s) + 3Cl_2(g) \longrightarrow 2AlCl_3(s)$$

A mixture of 3.00 moles of aluminium and 6.00 moles of chlorine are allowed to react.
(i) Which reactant is present in excess? [1 mark]
(ii) How many moles of the excess reactant are unreacted? [1 mark]
(iii) How many grams of aluminium chloride are formed? [2 marks]
[Atomic mass: Al = 27.0; Cl = 35.5]

b. The distinctive odour of vinegar is due to ethanoic acid, CH_3COOH. This acid reacts with aqueous sodium hydroxide in the following manner:

$$CH_3COOH(aq) + NaOH(aq) \longrightarrow NaCH_3COO(aq) + H_2O(l)$$

A 25.0 ml portion taken from a 1.0 L sample of vinegar required 1.30 g of sodium hydroxide for neutralization. What is the mass of ethanoic acid in the 1.0 L sample?
[Atomic mass: Na = 23.0, C = 12.0, O = 16.0, H = 1.0] [4 marks]

c. Methyl alcohol, CH_3OH, is used as a fuel in racing cars. This fuel can be manufactured from a reaction between gaseous hydrogen and carbon monoxide. Using 69.0 g of carbon monoxide and 8.56 g of hydrogen, 35.8 g of methyl alcohol is actually produced. What is the percentage yield?
[Atomic mass: C = 12.0, O = 16.0, H = 1.0] [5 marks]

d. Magnesium burns in nitrogen to give magnesium nitride, a yellow solid which has the formula Mg_3N_2. Magnesium nitride reacts with water to give ammonia and magnesium hydroxide.

(i) Construct a balanced equation for the reaction of magnesium nitride with water. [1 mark]
(ii) Does a redox reaction occur when magnesium nitride reacts with water? Use the oxidation numbers of nitrogen to explain your answer. [2 marks]

e. The equation below shows the reaction between nitrogen and oxygen.

$$N_2(s) + 2O_2(g) + 66\ kJ \longrightarrow 2NO_2(g)$$

(i) Is this an exothermic or endothermic reaction? Explain your answer. [1 mark]
(ii) Draw an energy diagram to represent energy changes for this reaction. [2 marks]
(iii) How much energy is needed for the formation of 0.1 moles of nitrogen dioxide? [1 mark]

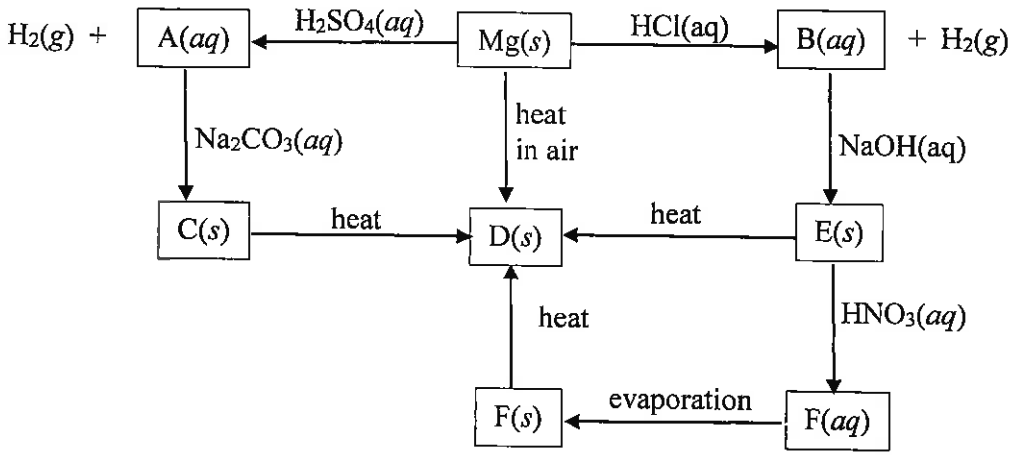
Continued.....

Question 2 [20 marks]

a. Complete the table below to show the electron configuration of calcium atom and of strontium ions, Sr^{2+}.
[Atomic number: Ca = 20; Sr = 38] [2 × 1 mark]

	1s	2s	2p	3s	3p	3d	4s	4p	4d
Ca	2	2	6						
Sr^{2+}	2	2	6						

b. Magnesium is the eighth most common element in the Earth's crust. The metal is widely used in alloys which are light and strong. Some reactions of magnesium and its compounds are shown in the reaction scheme below. Identify, by name or formula, compound A to F. [6 × 1 mark]



c. (i) In the table below, write the formulae of one of the oxides of each of these 5 elements. [2 marks]

Sodium	Magnesium	Aluminium	Phosphorus	Sulfur

(ii) Write an equation for sodium oxide reacting with water. [1 mark]
(iii) Write an equation for your chosen oxide of sulfur reacting with water. [1 mark]

Continued.....

d. This question refers to the element shown in the portion of the Periodic Table given below.

H																	He
Li	Be											B	C	N	O	F	Ne
Na	Mg											Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr

From this table, identify in each case one element that has the property described. Give the symbol of the element in each case.

(i) The element that has a molecule which contains exactly eight atoms. [1 mark]
(ii) The element that forms the largest cation. [1 mark]
(iii) An element that floats on water and reacts with it. [1 mark]
(iv) An element that reacts with water to give a solution that can behave as an oxidizing agent. [1 mark]

e. Consider the following electronic transitions in the hydrogen atom.

n = 1 to n = 4
n = 3 to n = 4
n = 3 to n = 2
n = 5 to n = 2

(i) Which transitions absorb energy? [1 mark]
(ii) Which transition absorbs the most energy? [1 mark]

f. Refer to the following elements and ions, which of them are isoelectronics? State the electron configuration for the isoelectronics. [2 marks]

S	O^{2-}	Cl	Mg
B	Ca^{2+}	Al^{3+}	Si

Question 3 [20 marks]

a. Write the Lewis dot symbols of the reactants and products in the following reactions.

(i) $Mg + Cl_2 \longrightarrow MgCl_2$ [2 marks]
(ii) $2Li + S \longrightarrow Li_2S$ [2 marks]

b. How many sigma bonds and pi bonds are there in each of the following molecules?

(i) $H_3C - CH_3$ [1 mark]
(ii) $H_3C - CH = CH_2$ [1 mark]
(iii) $CH_3 - C \equiv C - CH_2OH$ [1 mark]

Continued.....

c. Draw and name two molecular shapes for molecules having the VSEPR formulas AX_3E and AX_3E_2, respectively. [2 × 2 marks]

d. (i) Draw the Lewis structure of Thionyl chloride, $SOCl_2$, which is used as an oxidizing and chlorinating agent in organic chemistry. [2 marks]
(ii) Determine the number of lone pairs of electrons in this molecule. [1 mark]

e. Explain the following observation.
(i) Potatoes can be cooked more quickly by cutting it up into long strips. [2 marks]
(ii) Meat gets cooked faster when a pressure cooker is used. [2 marks]
(iii) Iron structures facing the seafront corrode more quickly. [2 marks]

Question 4 [20 marks]

a. An organic compound L has a melting point of −33°C and a boiling point of 66°C. In an experiment the compound L was heated steadily from −100°C to 100°C.
(i) Sketch a graph to show the change in temperature with time as compound L is heated. [3 marks]
(ii) State the physical state of L at the following temperatures:
(1) −100°C [1 mark]
(2) 0°C [1 mark]
(3) 100°C [1 mark]
(iii) Keeping temperature constant at 80°C, suggest how you can effect a change in state. [1 mark]

b. Explain the following observations.
(i) When a small quantity of ether is placed on the back of one's hand, a cold sensation is felt. [2 marks]
(ii) When ice is heated, the temperature stays constant at 0°C until all the ice has melted. [2 marks]
(iii) When 1 cm^3 of water is heated, the volume of steam obtained is more than a thousand times larger. [2 marks]

c. Nitrosyl bromide, NOBr, is formed from NO and Br_2.

$$2NO(g) + Br_2(g) \longrightarrow 2NOBr(g)$$

Experiments show that the reaction is second order with respect to NO and first order in Br_2.
(i) Write the rate equation for the reaction and state the overall order of reaction. [2 marks]
(ii) How does the reaction change if the concentration of Br_2 is tripled? [1 mark]
(iii) What happens to the reaction rate when the concentration of NO is doubled? [1 mark]

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d. Methanol and water are completely soluble in each other.
(i) Which intermolecular force exists between methanol molecules and water molecules that makes these two liquids soluble in each other? [1 mark]
(ii) Draw a diagram that clearly shows this intermolecular force. [2 marks]

Question 5 [20 marks]

a. For the reaction

$$(C_6H_5)_2(NH)_2 + I_2 \longrightarrow (C_6H_5)_2N_2 + 2HI$$

The following data were obtained in a series of experiments:

Experiment	$[(C_6H_5)_2(NH)_2]$/mol L^{-1}	$[I_2]$/mol L^{-1}	Initial rate/mol $L^{-1}s^{-1}$
1	0.010	0.010	2.0
2	0.010	0.020	4.0
3	0.030	0.020	12.0

(i) Determine the order of reaction with respect to $(C_6H_5)_2(NH)_2$. [2 marks]
(ii) Determine the order of reaction with respect to I_2. [2 marks]
(iii) Determine the rate equation. [1 mark]
(iv) Determine the rate constant. [1 mark]

b. The expression for an equilibrium constant, K_c, for a homogeneous equilibrium reaction is given below.

$$K_c = \frac{[A]^2[B]}{[C][D]^3}$$

(i) Write an equation for the forward reaction. [1 mark]
(ii) State what can be deduced from the fact that the value of K_c is much greater than 1 when the equilibrium is established at a constant temperature. [1 mark]
(iii) Given [A] = 0.050 M, [B] = 0.045 M, [C] = 0.086 M, and [D] = 0.040 M. Calculate K_c for the reaction at 686°C. [2 marks]

c. (i) Define an acid according to the Arrhenius theory, and write a balanced equation (use HCl as the acid) to support this definition. [2 marks]
(ii) Define a base according to the Brønsted-Lowry theory, and write a balanced equation (use CH_3NH_2 as the base) to support this definition. [2 marks]

d. Determine the pH of a KOH solution made by mixing 0.251 g KOH with enough water to make 1.00×10^2 mL of solution.
[Atomic mass: K = 39.1; O = 16.0; H = 1.0] [4 marks]

e. State two factors which determine the acid strength of oxoacids. [2 marks]

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